

A Mixed Level Analysis to Investigate the Factors Associated with Teenage Pregnancy in Bangladesh

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Abstract

This study aims to identify the potential determinants associated with teenage pregnancy in Bangladesh utilizing the Bangladesh Demographic and Health Survey (BDHS), 2017-18 clustered dataset. Random frailty term has been taken into account with the survival regression model to analyze the clustered data sets. Findings of this study have identified division, education of women and their partners, religion, working status, women's autonomy, and spousal age difference to be potential factors affecting women to experience pregnancy during adolescence age.

Keywords: Teenage pregnancy, Cluster, Random effect, Frailty

I. Introduction

Teenage pregnancy carries unfavorable health risks for both mother and child which is a common issue in marginalized countries including Bangladesh. Worldwide, around 21 million teenagers accept pregnancy intentionally or unintentionally during their adolescent age¹. Among them, 12 million finally came up with the process of delivery, especially, in least developed and developing countries². Complexity and intricacy emerged from pregnancy at an early age act as one of the prime sources of death penalty among adolescent mothers. Findings from previous surveys revealed that fifty percent of these pregnancies are inadvertent and involuntary resulting in additional distress². Moreover, pregnancy at an early age causes developing of sexually transmitted diseases and disorders in mental health of mothers along with the occurrence of detrimental health outcomes such as neonatal mortality, preterm delivery, still birth, low birth weight, preeclampsia/ eclampsia that have been found to be significantly associated with teenage pregnancy in the findings of previous studies^{3,4}.

Approximately, 95% of developing countries like Bangladesh encounter this serious early pregnancy problem during the adolescent period⁵. The percentage of females aged 15-19 years who have initiated childbearing is 28% in Bangladesh according to the report from Bangladesh Demographic and Health Survey (BDHS), 2017-18⁶. Of this percentage, 22% of females have so far given birth and 6% of females are expecting their first child. Reduction of the teenage birth rate is one of the 28 indicators of Sustainable Development Goal (SDG) 3 (Good Health and Well-being). Bangladesh government has gone through several awareness-rising programs and initiatives to diminish the rate of early pregnancy among adolescents but each of the attempts seems to fall flat to handicap this upward trend which alarms us the possibility of non-fulfillment of SDG criteria by 2030.

Different studies conducted on teenage pregnancy in Bangladesh and neighboring countries confirmed lower

rates of literacy, residence in rural places, and lower-ranked economic status to be potential factors to influence the rate of teenage pregnancy⁷⁻¹². A recent study on teenage pregnancy utilizing BDHS, 2014 and 2017-18 data set investigated the associated factors of teenage pregnancy using the logistic regression analysis¹³. However, no researches have been found to study adolescent pregnancy using survival analysis approach utilizing the most recent available data set of Demographic and Health Survey (DHS) in Bangladesh. As the DHS provides clustered data set, ignorance of correlation among responses into analysis may derive misleading results and incorrect estimates in statistical inferences¹⁴. Therefore, this study has focused on conducting additional investigation to expose the potential risk factors associated with teenage pregnancy in Bangladesh utilizing BDHS, 2017-18 data set using an appropriate survival regression model that can control the cluster effects and provide more efficient finding which may assist policy-makers to generate innovative schemes to coordinate the strategy and plan of action for the successful implementation and application of future endeavors.

II. Data and Methods

To serve the purpose of the study, data have been extracted from BDHS, 2017-18 data which is the eighth national-level survey in the context of Bangladesh, executed under the guidance and supervision of National Institute of Population Research and Training (NIPORT). Following a two-stage stratified sample of households, the survey selected 675 enumeration areas (EA), which serve as clusters, with probability proportional to EA size in the first stage. The second stage is executed by selecting 30 households from each of the selected EAs. Finally, BDHS successfully interviewed 20,127 ever-married women aged 15-49 years on a complete history of their live births with information on maternal and child health, fertility and family planning methods, and community-level data on the availability of healthcare access. A detailed discussion of the sample design has been provided in the BDHS, 2017-18 final report⁶.

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In order to analyze the potential factors associated with teenage pregnancy, defined as the pregnancy of women aged between 13-19 years¹⁵, the dependent variable has been considered as a time variable where the event of interest is experiencing the first pregnancy among teenagers and the failure time is defined as the age of teenage mothers at the time of their first pregnancy. For study purposes, respondents aged not more than 24 years have been considered in the sample entails the final sample of size 4613 individuals. Of those in the sample, 2684 have been found who conceived at or before 19 years and successfully delivered children. Moreover, there are 238 respondents who are currently pregnant and started their journey of pregnancy at teenage. In order to define the dependent variable more accurately, this study has also considered those pregnancies that started during the adolescent period but terminated on their journey. Therefore, age of respondents at the onset of terminated pregnancy has been included in the time variable. Finally, the number of events in the sample is found 3026 (65.6%) with 1587 (34.4%) censored observations.

On the basis of previous researches conducted on this area⁷⁻¹³, several variables have been considered that may have potential effect on teenage pregnancy. These variables are division, place of residence, education of women, religion, Partner's education level, wealth index, women autonomy, Media exposure, violence to women, working status of women, aware of family planning methods, and spousal age difference. The BDHS, 2017-18 dataset has evaluated decision-making power of women by collecting data on several distinct variables related to women's involvement in decision-making on household and health related issues. Four separate variables: people who take decision on health care of respondents, household related purchases, visiting relative's place, and the way household's earnings will be spent, have been integrated to form a single variable women's autonomy following factor analysis approach. Finally, the factor score has been treated as a continuous variable named women autonomy. However, as the factor score is in standardized form, the descriptive statistics along with log-rank test¹⁶ has been performed considering three categories (Low, Moderate, High) based on quantile values.

For the purpose of analyzing the clustered data extracted from BDHS, 2017-18 data set where enumeration areas serve as clusters, the Cox frailty model¹⁷ has been employed to take into account the possible correlation among responses within the same cluster. A survival frailty regression model¹⁷ is a random effect model for survival time where the frailty has a multiplicative effect on the hazard function. In this study, the choice of frailty term has been pivoted on gamma distribution and the penalized partial likelihood approach¹⁸ has been used for estimation of parameters. Assuming same baseline hazard function for each individual and distinct frailty for each cluster, the proportional hazard model for j^{th} individual in g^{th} cluster ($g = 1, 2, \dots, l, n = \sum_{g=1}^l n_g$) can be written as,

$$h_{gj}(t|u_g) = h_0(t) \exp(\beta'x_j + Z_jw);$$

where $h_{gj}(t|u_g)$ and $h_0(t)$ be the hazard functions at time point t in the presence and absence of covariates, respectively, x_j denote a $1 \times p$ vector of covariates with the corresponding regression parameter vector, β , and the frailty term, $u_g = \exp(w_g)$, where (w_g) being the random effect of cluster g , which is assumed to follow independent and identically distributed gamma variate with mean 1 and variance θ , and Z is a $n \times q$ matrix with q indicator variables such that $Z_{gj} = 1$, if subject j belongs to family g , and 0, otherwise. Under this set up, the penalized partial log-likelihood (PPL) function with $g(w; \theta)$ being the penalty function can be written as¹⁸

$$PL = PL(\beta, w; data) - g(w; \theta);$$

where,

$$PL(\beta, w; data) = \sum_{i=1}^n \int_0^{\infty} \left[Y_i(t)(X_i\beta + Z_iw) - \log \left\{ \sum_k Y_k(t) \exp(X_k\beta + Z_kw) \right\} \right] dN_i(t),$$

with $Y_i(t)$ being the indicator that a given subject is at risk and under observation at time point t and $N_i(t)$ is the cumulative number of events for the subject up to time t ; and $g(w; \theta) = \frac{1}{\theta} \sum_{g=1}^l [w_g - \exp(w_g)]$.

In this study, Software R has been used for inference where the internal estimation technique was Expectation Maximization (EM) algorithm suggested by Therneau et al.¹⁸.

III. Results

At first phase, univariate analysis of each of the selected covariates has been conducted. Afterwards, the log-rank test¹⁶ p-values have been evaluated to find out significant unadjusted association between dependent variable and each of the selected covariates. The results obtained from univariate and bivariate analysis have been presented in Table 1.

Table 1 shows that about two-thirds of women (65.6%) got pregnant during their adolescent period. The 95% confidence interval (CI) of median survival time has been observed (17.734, 17.932) years which implies that 50% of women experience teenage pregnancy before completing 18 years which is alarming. Moreover, the percentage of teenage pregnancy is found higher among women from Mymensingh division, residing in rural areas, followers of Islam religion, currently working, victims of intimate partner violence, non-exposure to media, and not aware of family planning methods. However, the rates of teenage pregnancy have been found to decrease with the increase of women's autonomy power in their household and the educational level of mothers as well as their partners. Moreover, women from economically solvent families and a lesser age gap with their partners tend to have a lower rate of teenage pregnancy. According to log-rank test p-values, all these variables proved to pose a significant association with teenage pregnancy.

To find out the potential factors associated with teenage pregnancy, both Cox PH¹⁹ and Cox frailty models have been applied to the data. Akaike's Information Criteria (AIC) values for Cox PH¹⁹ and Cox frailty model have been found 47627.12 and 47588.489, respectively. This suggests that Cox frailty model provides a better fit compared to Cox PH

model. However, regression results only for the well-fitted Cox frailty model have been displayed in the paper. The regression analysis results obtained from the semi-parametric frailty model (Cox frailty model) have been presented in Table 2.

Table 1. Descriptive statistics along with log-rank test p-values for each of the selected covariates for teenage pregnancy in Bangladesh

Variables	Frequency (Percentage)	Teenage pregnancy status		p-value
		Yes (%)	No (%)	
Division				<0.001
Dhaka	720 (15.6)	59.9	40.1	
Chattogram	730 (15.8)	68.4	31.6	
Barisal	478 (10.4)	64.0	36.0	
Khulna	555 (12.0)	64.7	35.3	
Mymensingh	537 (11.6)	69.8	30.2	
Rajshahi	574 (12.4)	66.6	33.4	
Rangpur	542 (11.7)	69.6	30.4	
Sylhet	477 (10.3)	62.3	37.7	
Place of residence				<0.001
Rural	3038 (65.9)	67.8	32.2	
Urban	1575 (34.1)	61.4	38.6	
Education of women				<0.001
Below primary	1186 (25.7)	79.3	20.7	
Secondary	2476 (53.7)	69.5	30.5	
Higher	951 (20.6)	38.4	61.6	
Religion				0.078
Other	358 (7.8)	62.8	37.2	
Islam	4255 (92.2)	65.8	34.2	
Wealth index				<0.001
Poor	1828 (39.6)	74.8	25.2	
Middle	915 (19.8)	66.8	33.2	
Rich	1870 (40.5)	56.0	44.0	
Partner's education level				<0.001
Below primary	1979 (42.9)	76.5	23.5	
Secondary	1737 (37.7)	64.8	35.2	
Higher	897 (19.4)	43.3	56.7	
Women's autonomy				<0.001
Less	1744 (37.8)	70.3	29.7	
Moderate	1338 (29.0)	64.9	35.1	
High	1531 (33.2)	60.9	39.1	
Working status of women				<0.001
No	3177 (68.9)	62.2	37.8	
Yes	1436 (31.1)	73.2	26.8	
Violence towards women				<0.001
No	3783 (82.0)	64.3	35.7	
Yes	830 (18.0)	71.7	28.3	
Media exposure				<0.001
Non-exposure	1479 (32.1)	72.2	27.8	
exposure	3134 (67.9)	62.5	37.5	
Aware of family planning				<0.001
No	3882 (84.2)	67.0	33.0	
Yes	731 (15.8)	58.4	41.6	
Spousal age difference				0.001
(0-5) year	1396 (30.3)	62.7	37.3	
(5-10) year	2056 (44.6)	66.8	33.2	
>10 year	1152 (25.0)	67.2	32.8	
< 0	9 (0.2)	44.4	55.6	
Total	4613	65.6	34.4	
Median survival time (Years)		17.83		
95% CI		(17.734, 17.932)		

Table 2 exhibits that the divisions Chattogram, Barisal, Khulna, Mymensingh, Rajshahi, Rangpur except Sylhet are inhabited by those mothers who have significantly 23.7%, 19.3%, 27.7%, 18.8%, 26.0%, and 42.1% higher hazard of experiencing teenage pregnancy than that of mothers who have taken up residence in Dhaka, respectively. Both the variables education of women and partner's education level have a significant impact on the prevalence of teenage pregnancy satisfying the traditional belief that education possesses the enchanting power to diminish the rate of teenage pregnancy. Respondents who are secondary and highly educated have 23.3% and 65.9% lower hazard of experiencing pregnancy before 19 years of age compared to respondents who have below primary education level, respectively. Moreover, respondents whose partners have secondary or higher education levels have respectively 14.4% and 36.6% lower hazard of getting pregnant during their adolescent period compared to those of below primary educated partners.

It has been found that Muslim respondents have a significantly 17.8% higher hazard of experiencing pregnancy at an adolescent stage in comparison with respondents who are followers of other religions. Besides, respondents who are affluent, classified into the rich category, have a 14.3% lower hazard of experiencing teenage pregnancy compared to respondents having a lack of solvency stated as poor respondents. Moreover, mothers who are involved in money-making working activities have 1.229 times hazard rate of experiencing pregnancy during their adolescent period compared to that of mothers who are not engaged in such type of activities. A negative coefficient (-0.102) corresponding to the continuous variable women's autonomy indicates for every additional factor score of women's autonomy, the risk of experiencing teenage pregnancy falls by 9.7%. Moreover, respondents with spousal age differences 5-10 years and more than 10 years have respectively 28.6% and 44.5% higher hazard rates of adolescent pregnancy compared to respondents having age differences of 0-5 years with their partners. On the contrary, place of residence, media exposure, violence to women, aware of family planning methods have been found insignificant as a result of failing to provide concrete evidence.

IV. Conclusion

The study analyzes teenage pregnancy in Bangladesh utilizing a well-fitted semi-parametric frailty survival regression model that can control the random effects of clusters. This finding indicates that women residing in Dhaka division are more aware of avoiding pregnancies during their adolescent period compared to those of other divisions. This study also confirms a negative association between maternal education level and teenage pregnancy. That is the higher the education level of mothers, the lower the risk of experiencing teenage pregnancy which is in tune with the findings of some previous studies^{12,20}. Similar findings have been observed in the case of partner's education. The fact that education for both partners

improves the knowledge regarding reproductive health issues, may contribute to reducing the chance of adolescent pregnancy. Moreover, similar to previous findings by Sarder et al.¹², it has been observed that Muslim women are at higher risk of getting pregnant during the adolescent period compared to non-muslim women. The reason behind this context may be due to the contemplation of muslim mothers which motivates them to preclude the notion of contraceptive methods on account of the contradictory appearance with their religious beliefs. It has also been noticed that women from solvent families have less inclination to get pregnant at an early age compared to their counterparts who are in poor economic conditions which is in conformity with the previous studies^{12,21,22}. Poverty might be the factor that leads poor women to childbearing with the hope of getting financial security from their offspring in their old age. This study has exposed that women's autonomy power in terms of decision-making in household and health-related issues can contribute to lessening the risk of childbearing during the adolescent period. A study by Shahabuddin has identified that adolescent women exhibit less power in making decisions for childbearing resulting in an increasing rate of teenage pregnancy²³. However, a recent study using BDHS, 2017-18 data revealed women's involvement in decisions of healthcare-related issues has no significant role in controlling the rate of teenage pregnancy which is contradictory to this study¹³. Furthermore, this study also reveals that a low gap between the husband and wife's age reduces the risk of pregnancy during the adolescent period which is compatible with the research by Sarder et al.¹² but contradicts the finding from a recent study in Bangladesh¹³. This finding from the study indicates that lower spousal age differences might act to eliminate the communication gap between spouses and increase involvement in making decisions regarding family planning and the use of contraceptives. This study also pointed out that women currently involved with working activities are more likely to experience pregnancy during their adolescent period compared to women not involved in such types of activities. This may be due to the fact that women with the propensity to engross themselves in money-making activities in their future lives move for early childbearing than the mothers who do not have the rush to enroll in working activities. However, the scenario was exposed opposite in a study in Bangladesh conducted using BDHS, 2014 data¹². On the contrary, place of residence, media exposure, knowledge of family planning, and violence towards women turn out to be insignificant in this study.

Based on the findings of this study, it is essential to develop beneficial interventions to lessen the rate of adolescent pregnancy and thereby improve maternal and child health. Fruitful schemes need to be organized that will work out to decrease the rate of teenage pregnancy. Programs to raise awareness regarding the adverse impact of teenage pregnancy should be decentralized to the regional level. Moreover, women's autonomy in decision-making has to be assured in households and health-related issues to reduce the prevalence of experiencing pregnancy during adolescent age.

Table 2. Cox frailty model estimates of regression coefficients (β) with standard error (SE), p-values, hazard ratios (HR) and confidence intervals (CI) of hazard ratios for selected socioeconomic and demographic covariates

Variables	β	SE (β)	p-value	HR	CI
Division					
Dhaka	-	-	-	-	-
Chattogram	0.212	0.075	0.005	1.237	(1.055, 1.418)
Barisal	0.177	0.087	0.042	1.193	(0.993, 1.395)
Khulna	0.245	0.081	0.003	1.277	(1.075, 1.480)
Mymensingh	0.173	0.082	0.038	1.188	(0.997, 1.379)
Rajshahi	0.231	0.081	0.005	1.260	(1.060, 1.460)
Rangpur	0.351	0.083	<0.001	1.421	(1.190, 1.653)
Sylhet	-0.130	0.087	0.140	0.878	(0.729, 1.028)
Place of residence					
Rural	-	-	-	-	-
Urban	-0.037	0.048	0.440	0.964	(0.873, 1.054)
Education of women					
Below primary	-	-	-	-	-
Secondary	-0.265	0.045	<0.001	0.767	(0.670, 0.835)
Higher	-1.077	0.074	<0.001	0.341	(0.291, 0.390)
Religion					
Other	-	-	-	-	-
Islam	0.164	0.074	0.027	1.178	(1.007, 1.349)
Partner's education level					
Below Primary	-	-	-	-	-
Secondary	-0.156	0.044	<0.001	0.856	(0.784, 0.928)
Higher	-0.455	0.068	<0.001	0.634	(0.551, 0.717)
Wealth index					
Poor	-	-	-	-	-
Middle	-0.077	0.054	0.150	0.926	(0.830, 1.022)
Rich	-0.154	0.056	0.006	0.857	(0.763, 0.951)
Working status of women					
No	-	-	-	-	-
Yes	0.206	0.041	<0.001	1.229	(1.130, 1.328)
Media exposure					
Non-exposure	-	-	-	-	-
Exposure	0.003	0.046	0.960	1.003	(1.130, 1.328)
Women's autonomy	-0.102	0.020	<0.001	0.903	(0.870, 0.937)
Violence to women					
No	-	-	-	-	-
Yes	0.062	0.048	0.190	1.064	(0.966, 1.162)
Aware of family planning					
No	-	-	-	-	-
Yes	-0.024	0.057	0.670	0.976	(0.869, 1.083)
Spousal age difference					
(0-5) year	-	-	-	-	-
(5-10) year	0.252	0.045	<0.001	1.286	(1.175, 1.397)
>10 year	0.368	0.051	<0.001	1.445	(1.300, 1.589)
Less than zero	-0.680	0.508	0.180	0.507	(0.002, 1.011)
Variance of random effect	0.045				

References

1. World Health Organization., 2019. Adolescent pregnancy.
2. Darroch, J.E., Woog, V., Bankole, A. and Ashford, L.S., 2016. Adding it up: costs and benefits of meeting the contraceptive needs of adolescents.
3. UNICEF., 2008. *Maternal and Newborn Health*.
4. Zhang, T., Wang, H., Wang, X., Yang, Y., Zhang, Y., Tang, Z. and Wang, L., 2020. The adverse maternal and perinatal outcomes of adolescent pregnancy: a cross sectional study in Hebei, China. *BMC Pregnancy and Childbirth*, **20(1)**, 1-10.
5. Loaiza, E. and Liang, M., 2013. *Adolescent pregnancy: a Review of the Evidence*. Unfpa.
6. Bangladesh Demographic and Health Survey (BDHS)., 2017-18, NIPORT, Dhaka, Bangladesh; Mitra and Associates, Dhaka/ Bangladesh.
7. Shrestha, S., 2002. Socio-cultural factors influencing adolescent pregnancy in rural Nepal. *International Journal of Adolescent Medicine and Health*, **14(2)**, 101-110.
8. Acharya, D.R., Bhattaria, R., Poobalan, A.S., van Teijlingen, E. and Chapman, G.N., 2010. Factors associated with teenage pregnancy in South Asia: a systematic review. *Health Science Journal*, **4(1)**, 3-14.
9. Poudel, S., Upadhaya, N., Khatri, R.B. and Ghimire, P.R., 2018. Trends and factors associated with pregnancies among adolescent women in Nepal: Pooled analysis of Nepal Demographic and Health Surveys (2006, 2011 and 2016). *PLOS One*, **13(8)**, e0202107.
10. Islam, M.M., Islam, M.K., Hasan, M.S. and Hossain, M.B., 2017. Adolescent motherhood in Bangladesh: Trends and determinants. *PLOS One*, **12(11)**, e0188294.
11. Sayem, A.M. and Nury, A.T.M., 2011. Factors associated with teenage marital pregnancy among Bangladeshi women. *Reproductive health*, **8(1)**, 1-6.
12. Sarder, M.A., Alauddin, S. and Ahammed, B., 2020. Determinants of teenage marital pregnancy among bangladeshi women: An analysis by the cox proportional hazard model. *Asian Journal of Social Health and Behavior*, **3(4)**, 137-143.
13. Alam, N., Mollah, M.M.H. and Naomi, S.S., 2023. Prevalence and determinants of adolescent childbearing: comparative analysis of 2017–18 and 2014 Bangladesh Demographic Health Survey. *Frontiers in Public Health*, **11**, 1088465.
14. Ntani, G., Inskip, H., Osmond, C. and Coggon, D., 2021. Consequences of ignoring clustering in linear regression. *BMC Medical Research Methodology*, **21**, 1-13.
15. Ganchimeg, T., Ota, E., Morisaki, N., Laopaiboon, M., Lumbiganon, P., Zhang, J., Yamdamsuren, B., Temmerman, M., Say, L., Tunçalp, Ö. and Vogel, J.P., 2014. Pregnancy and childbirth outcomes among adolescent mothers: a World Health Organization multicountry study. *BJOG: An International Journal of Obstetrics & Gynaecology*, **121(s1)**, 40-48.
16. Mantel, N. and Haenszel, W., 1959. Statistical aspects of the analysis of data from retrospective studies of disease. *Journal of the National Cancer Institute*, **22(4)**, 719-748.
17. Duchateau, L. and Janssen, P., 2008. *The frailty model*. New York: Springer Verlag.
18. Therneau, T.M., Grambsch, P.M. and Pankratz, V.S., 2003. Penalized survival models and frailty. *Journal of Computational and Graphical Statistics*, **12(1)**, 156-175.
19. Cox, D.R., 1972. Regression models and life-tables. *Journal of the Royal Statistical Society: Series B (Methodological)*, **34(2)**, 187-202.
20. Kassa, G.M., Arowojolu, A.O., Odugogbe, A.A. and Yalew, A.W., 2018. Prevalence and determinants of adolescent pregnancy in Africa: a systematic review and meta-analysis. *Reproductive Health*, **15(1)**, 1-17.
21. Wado, Y.D., Sully, E.A. and Mumah, J.N., 2019. Pregnancy and early motherhood among adolescents in five East African countries: a multi-level analysis of risk and protective factors. *BMC Pregnancy and Childbirth*, **19(1)**, 1-11.
22. Ayele, B.G.K., Gebregzabher, T.G., Hailu, T.T. and Assefa, B.A., 2018. Determinants of teenage pregnancy in Degua Tembien District, Tigray, Northern Ethiopia: A community-based case-control study. *PLOS One*, **13(7)**, e0200898.
23. Shahabuddin, A.S.M., Nöstlinger, C., Delvaux, T., Sarker, M., Bardaji, A., Brouwere, V.D. and Broerse, J.E., 2016. What influences adolescent girls' decision-making regarding contraceptive methods use and childbearing? A qualitative exploratory study in Rangpur District, Bangladesh. *PLOS One*, **11(6)**, e0157664.